

1993.10.11

KES

Involute Spline

KES C-D008

(EST.) 1990-06-30

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1. Scope of Application

This standard provides for essential information for straight(non-helical) involute splines having teeth with involute profiles which are used mainly in automobile mechanisms, specifically coupling drive shafts and mating holes each other, hereinafter referred to as "spline."

Note: The DP spline in this standard conforms to the Michigan Tool Co. ROTO-FLD Spline And Serration Standards, and the module spline conforms to the JIS D2001(automobile spline).

2. Definition of Terminology

Definition of Terminology in this standard conforms to the JIS D2001(automobile involute spline) and SAE J 4986.

3. Types

- (1) Spline group has two types, the DP and the module.
- (2) The main components of the spline are shown in Table 1.

Table 1. Main Components

Main components Groups	Size of teeth	Number of teeth	Pressure angle of basic pitch circle	Shift value
DP	$P = 24$	$17 \sim 40$	30°	0
Module	$k_m = 1.667^{(1)}$ 2.0, 2.5	$6 \sim 40$	20°	$+ 0.8 m^{(1)}$

Note(1) Module $m=1.677$, set shift amount of tooth 8 to $+0.9m$ in order to coincide it with the diameter of the bearing that oscillates dimensional tolerance.

4. Basic Form of Tooth

Standard rack of tooth form DP and module spline are shown in Fig. 1 and 2.

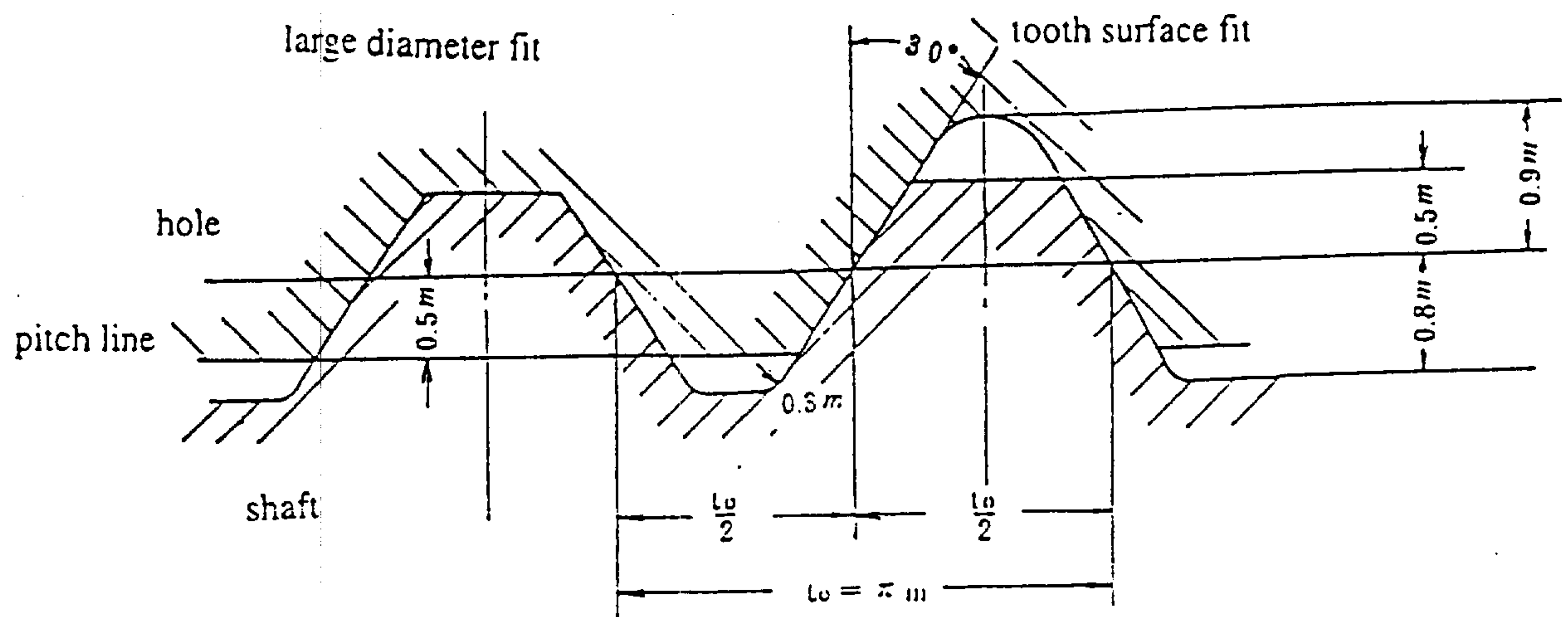


Fig. 1. Standard rack of DP type spline (converted to module)

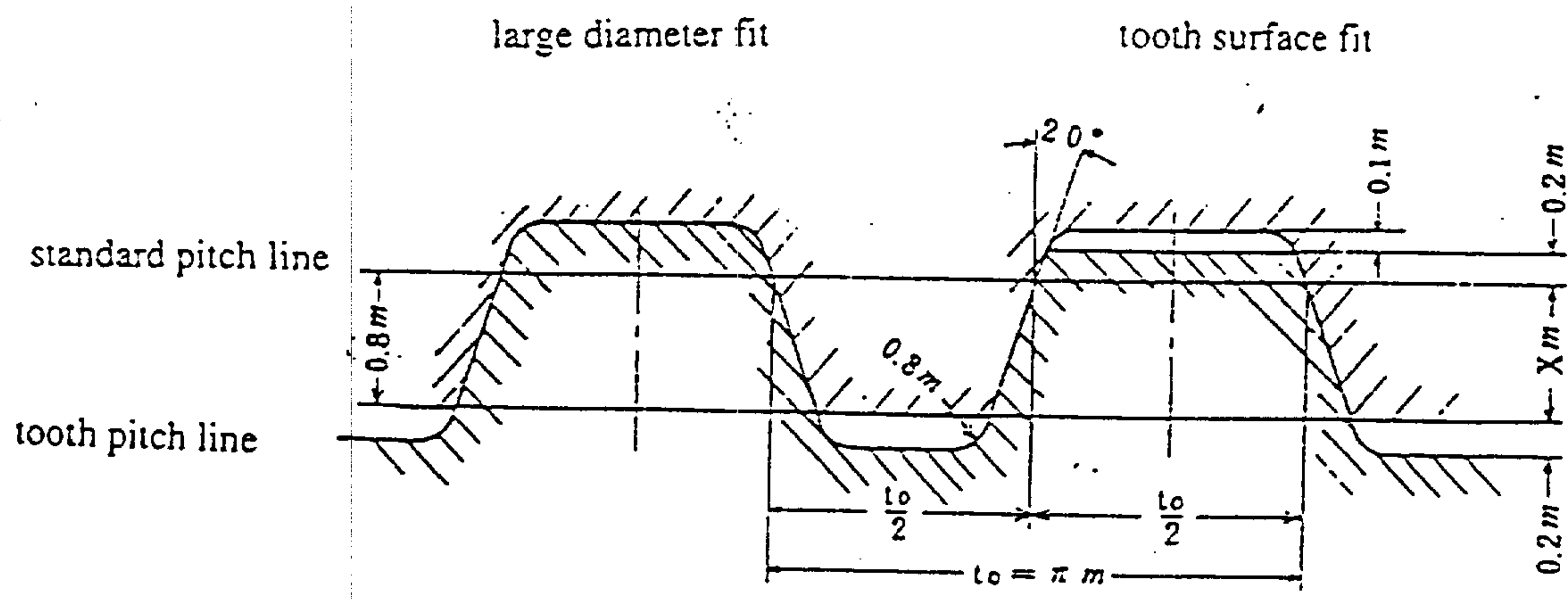


Fig. 2. Standard rack of module spline

5. Symbols and Formulas

Symbols adopted in this standard conform to the tooth symbols, except in cases otherwise specified. Dimension calculation of each spline part is as follows:

(1) DP type Spline (unit: inches)

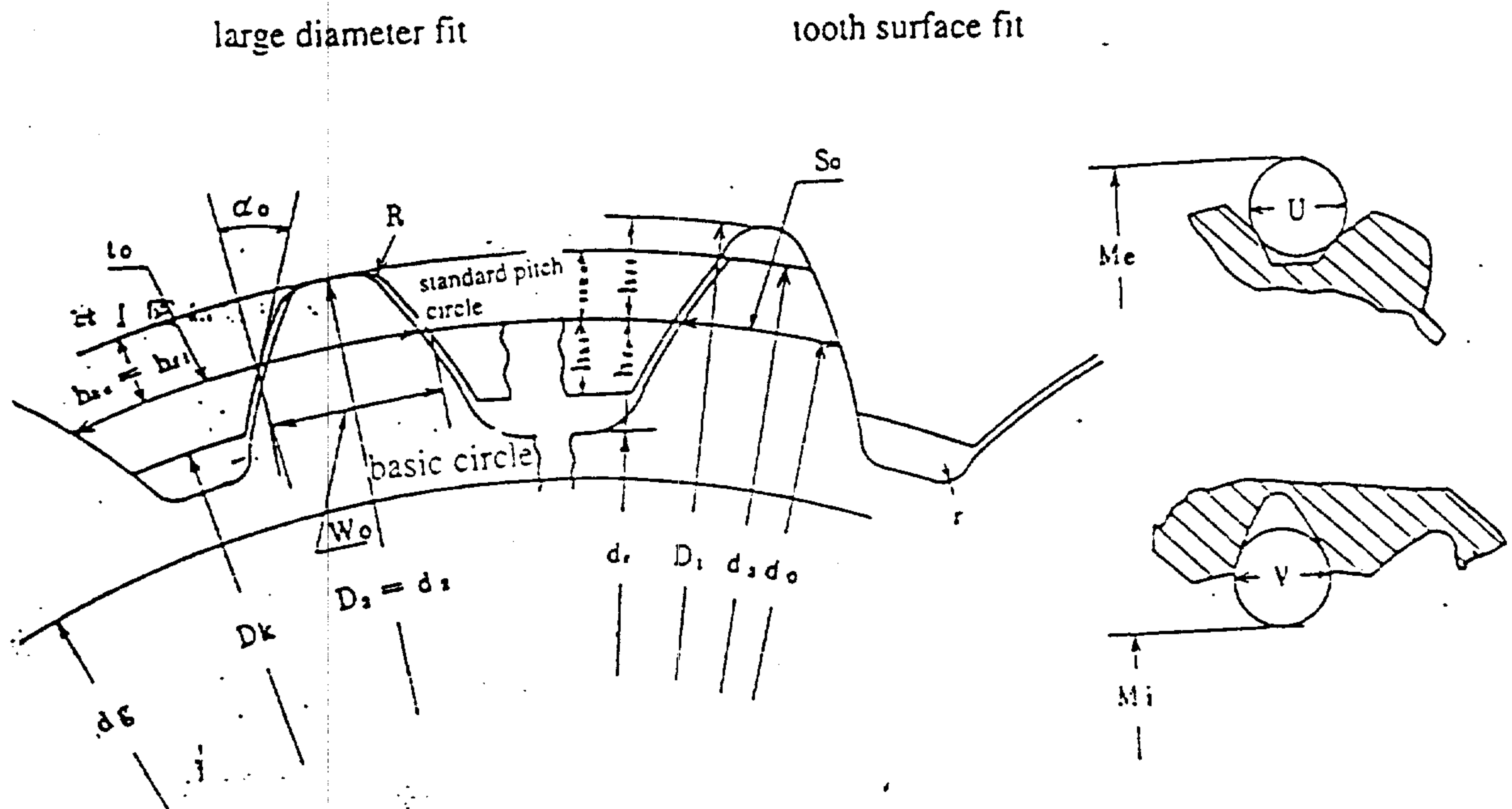


Fig. 3. Symbols

standard pitch circle diameter: $d_o = \frac{Z}{P}$ (z- number of teeth : p- diametral pitch)

major diameter of spline hole (in the case of flank fit) : $D_1 = d_o + 2h_{fi} = \frac{Z}{P} + 2 \cdot \frac{1.8}{PS} = \frac{Z + 1.8}{P}$

(PS is Stub Pitch = 2P)

major diameter of spline hole (in the case of major diameter fit) : $D_2 = d_o + 2h_{fi} = \frac{Z}{P} + 2 \cdot \frac{1}{PS} = \frac{Z + 1}{P}$

minor diameter of spline hole: : $D_k = d_o - 2 \cdot h_{ki} = \frac{Z}{P} - 2 \cdot \frac{1}{PS} = \frac{Z - 1}{P}$

minor diameter of spline shaft: $d_o - 2h_{re} = \frac{Z}{P} - 2 \cdot \frac{1.6}{PS} = \frac{Z - 1.6}{P}$

pressure angle on basic pitch circle: : $\alpha_o = 30^\circ$

basic circle diameter: $d_f = d_o \cos d_o$

basic pitch: $t_o = \frac{\pi}{P}$

tooth thickness of shaft basic pitch circle: $S_o = \frac{\pi}{2P} = 0.5 t_o$

tooth hole width of hole basic pitch circle: $W_o = S_o$

diameter of overpin of spline hole : $M_i = \frac{d_f}{\cos d_i} - v$ (v: calculative pin diameter) (even number of teeth)

$$= \frac{d_y}{\cos d_i} \cdot \cos \frac{\pi}{2Z} - v \quad (\text{odd number of teeth})$$

However, d_i is the pressure angle of calculative pin center and conforms to the following formulas.

$$\text{inv} d_i = \text{inv} d_o + \frac{W_o}{d_o} - \frac{v}{d_f}$$

overpin diameter of shaft : $M_e = \frac{d_y}{\cos d_e} + u$ (u: calculative pin diameter) (even number of teeth)

$$= \frac{d_y}{\cos d_e} \cdot \cos \frac{\pi}{2Z} + u \quad (\text{odd number of teeth})$$

Except, d_e is the pressure angle of calculative pin center and conforms to the following formula.

$$\text{inv} d_e = \text{inv} d_o + \frac{S_o}{d_o} + \frac{u}{d_f} - \frac{\pi}{Z}$$

overpin diameter coefficient of hole: $\frac{\Delta M_i}{\Delta W_o} = \frac{1}{\sin d_i}$ (even number of teeth)

$$= \frac{1}{\sin d_i} \cdot \cos \frac{\pi}{2Z} \quad (\text{odd number of teeth})$$

overpin diameter coefficient of shaft: $\frac{\Delta M_i}{\Delta S_o} = \frac{1}{\sin d_e}$ (even number of teeth)

$$= \frac{1}{\sin d_e} \cdot \cos \frac{\pi}{2Z}$$

(odd number of teeth)

Note: The overpin diameter used in this standard is calculated using the pin in appendix 1, but in the case of using a pin of which the diameter is different, the overpin diameter calculation follows the program No. Sool 2A1 (involute gear) manual.

(2) module type spline

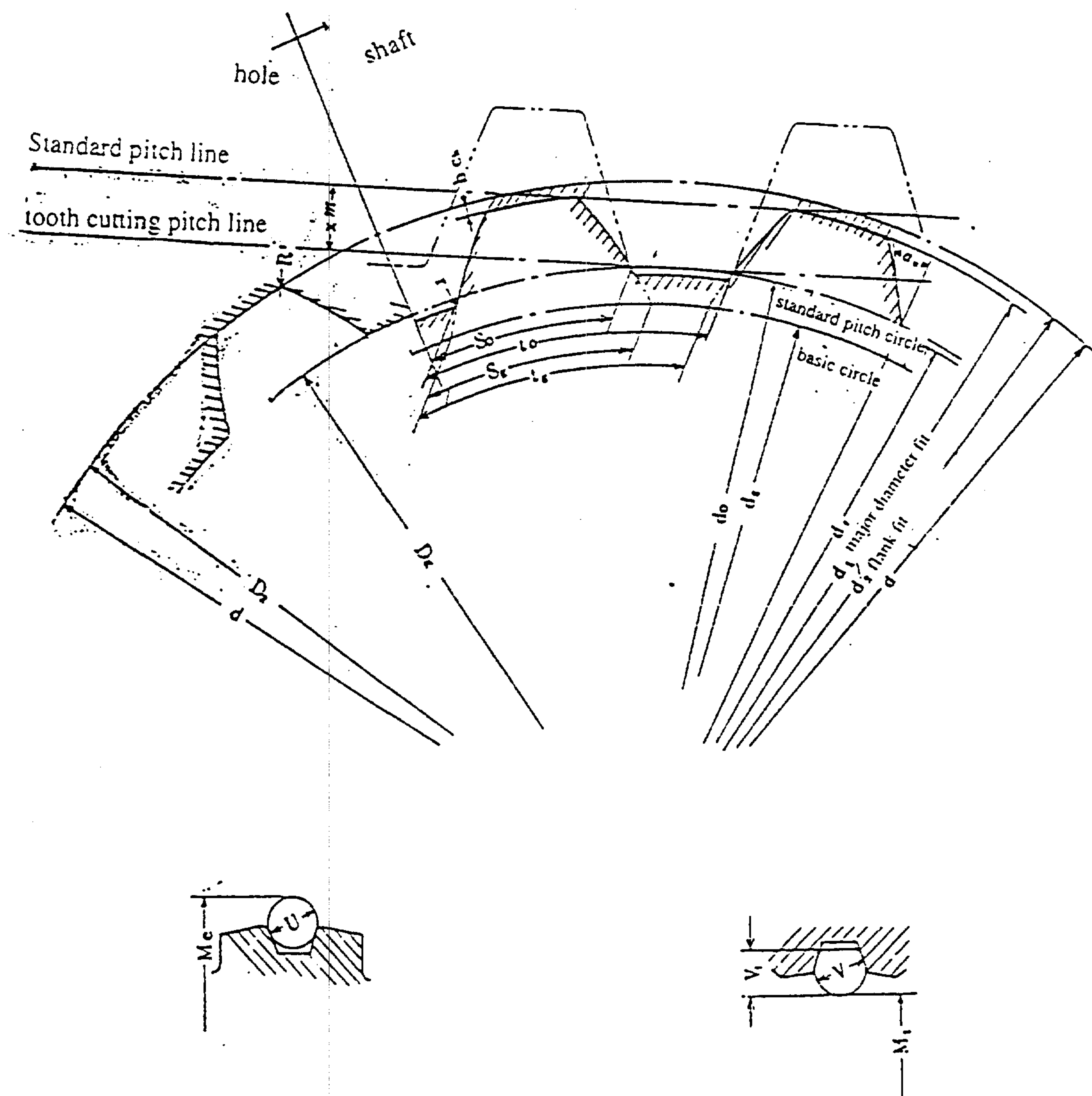


Fig. 4

measurement : $d = (Z + 2) m$ (z: number of teeth ; m: module)

Except, besides in the case of amount of shift $x=0.8$, measurement formula is as follows:

$$d = (Z + 2X + 0.4) m$$

major diameter of hole (flank fit, major diameter fit) : $D_2 = d$

major diameter of shaft (flank fit) : $d_1 = d - 0.2 m$

major diameter of shaft (major diameter fit) : $d_2 = d$

minor diameter of hole : $D_k = d - 2 m$

minor diameter of shaft : $d_r = d - 2.4 m$

standard pitch circle diameter: $d_o = Z m$

pressure angle of standard pitch circle : $d_o = 20^\circ$

Note(2) central pressure angle of actual tooth size : $d \approx 30^\circ$

standard circle diameter: $d_r = d_o \cos d_o$

standard pitch: $t_o = \pi m$

circular pitch on a standard circle: $t_r = t_o \cos a_o$

coefficient of shift: $x = \frac{d - m (Z + 0.4)}{2m}$

tooth hole width of hole on a standard pitch circle: $w_o = \frac{\pi m}{2} + 2xm \cdot \tan d_o$

tooth thickness of shaft on a standard pitch circle: $S_o = w_o$

tooth hole width of hole on a basic circle: $w_r = w_o \cdot \cos d_o + d_r \cdot \text{inv } d_o$

tooth thickness of shaft on a basic circle: $S_r = w_r$

overpin diameter of hole: $M_1 = \frac{d_r}{\cos d_1} - V$ (v: calculative pin diameter) (even number of teeth)

$$= \frac{d_r}{\cos d_1} \cdot \cos \frac{\pi}{2Z} - V \quad (\text{odd number of teeth})$$

Except, d_1 is the central pressure angle of the calculative pin, and conforms to the following formula.

$$\text{inv } d_1 = \text{inv } d_o + \frac{W_o}{d_o} - \frac{V}{d_r}$$

$$\begin{aligned} \text{overpin diameter of shaft: } M_e &= \frac{d_r}{\cos d_e} + U \quad (U: \text{calculative pin diameter})(\text{even number of teeth}) \\ &= \frac{d_r}{\cos d_e} \cdot \cos \frac{\pi}{2Z} + U \quad (\text{odd number of teeth}) \end{aligned}$$

Except, d_e is the central pressure angle at the center of the calculative pin, and it is calculated as follows:

$$\text{inv } d_e = \text{inv } d_o + \frac{S_o}{d_o} + \frac{S_r}{d_r} + \frac{U}{d_r} - \frac{\pi}{Z}$$

$$\text{overpin diameter coefficient of hole: } \frac{\Delta M_i}{\Delta W_r} = \frac{1}{\sin d_1} \quad (\text{even number of teeth})$$

$$= \frac{1}{\sin d_1} \cdot \cos \frac{\pi}{2Z} \quad (\text{odd number of teeth})$$

$$\text{overpin diameter coefficient of shaft: } \frac{\Delta M_e}{\Delta S_r} = \frac{1}{\sin d_e} \quad (\text{even number of teeth})$$

$$= \frac{1}{\sin d_e} \cdot \cos \frac{\pi}{2Z} \quad (\text{odd number of teeth})$$

$$\text{are serration addendum of shaft (greatest): } r = \frac{0.2}{1 - \sin \alpha} \cdot m = 0.3 m$$

$$\text{Radial height of tooth blade of shaft: } h_{ch} = 0.1 m$$

Note :

The overpin diameter used in this standard is calculated using the pin in appendices 2~4, but in the case of using a pin of which the diameter is different, the overpin diameter calculation follows the program No. Sool 2AI (involute gear) manual.

6. Central Alignment and Fit

6.1 central alignment

Central alignment methods of spline are the following two types:

(1) flank fit

A method of alignment by tooth flank surfaces

(2) major diameter fit

A method of alignment by major diameter surfaces

6.2 fitting

Types of spline fitting and fitting of each part are shown in Tables 2 and 3.

Table 2. Types of fitting

Fitting	Standard of application
loose fit	Manual junction which the interval is relatively wide
sliding fit	Manual junction which the interval is relatively narrow
fixing fit	Fixed junction which the interval is specially narrow
press fit	Fixed junction which decomposition is almost unnecessary

Central alignment fitting		Group		DP				Module							
		category		actyak measunement of tooth flank		major diameter		minor diameter		actyak measunement of tooth flank		major diameter		minor diameter	
		hole	shift	hole	shaft	hole ⁽³⁾	shaft	hole	shift	hole	shaft	hole ⁽³⁾	shaft		
tooth flank fit	lose fit	H9	C10	+0.200 0	0	H11	h12	H 9 H10	C10	N8	-	H11	-		
	sliding fit		f10						f10						
	fixing fit		H10						js10					js10	
	press fit		x10						x10						
major diameter fit	sliding fit	H9 H10	c10	H8	g7	H11	h12	H 9 H10	c10	N8		H11	-		
	fixing fit		f10						c10 f10						

Note(3): When using the broached working standard hole, the minor diameter of hole applies to H8 or H7, regardless of the regulation.

Remark 1 Greatest margin, maximum interval, and minimum interval of tooth surface fit conforms to appendix 5.

- Actual measurement of tooth flank fit is measured on the standard pitch circle in case of DP spline, and with basic circle in case of module spline.
- H9, the allowable error in actual measurement of hole and tooth flank, is, in principle, not handled with heat after the process, or used when the differentiation after heat treatment is small. H10 is treated with heat after the process, and is used when the differentiation after heat treatment is great or in case of sintering.

7. Accuracy of Tooth Surface

7.1. allowable difference in tooth hole

Allowable difference in tooth hole conforms to the JIS B 1702-1960 (accuracy of Cspur gear and helical gear) grades 5 and 6, and is shown in Table 4.